

## CLAIMS

1. An optical wavelength division multiplexing access system, whereby a center node (OSU) and n optical network units (ONUs) are arranged by using a W-MULDEM unit, whereby a multiplexing section between said OSU and said W-MULDEM unit is established by extending a current-use optical fiber and a redundant optical fiber and access sections between said W-MULDEM unit and said individual ONUs are established by the extension of optical fibers, whereby downstream optical signals from said OSU to said ONUs and upstream optical signals from said ONUs to said OSU are multiplexed using wavelengths that are allocated to individual ONUs and the resultant signals are transmitted across said multiplexing section, and whereby said W-MULDEM unit performs wavelength multiplexing or wavelength demultiplexing for said upstream or downstream optical signals to provide bidirectional transmission, characterized in that:

the OSU includes

transmission means for multiplexing downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dn}$  that correspond to said ONUs and that are to be transmitted to said ONUs along said current-use optical fiber, for multiplexing downstream optical signals having wavelengths  $\lambda_{d1} + \Delta\lambda$  to  $\lambda_{dn} + \Delta\lambda$  that correspond to said ONUs and that are to be transmitted to said ONUs along said redundant

optical fiber, and for selecting either said current-use optical fiber or said redundant optical fiber for use for transmission, and

reception means for receiving upstream optical signals having wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$  along said current-use optical fiber or for receiving upstream optical signals having wavelengths  $\lambda_{u1} + \Delta\lambda$  to  $\lambda_{un} + \Delta\lambda$  along said redundant optical fiber;

the individual ONUs receive corresponding downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dn}$  or corresponding downstream optical signals having wavelengths  $\lambda_{d1} + \Delta\lambda$  to  $\lambda_{dn} + \Delta\lambda$ , which are received along said optical fibers extended across said access sections, the individual ONUs transmit, to said optical fibers extended across said access sections, corresponding upstream optical signals that have wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$  and are to be transmitted along said current-use optical fiber extended across said multiplexing section, or corresponding upstream optical signals that have wavelengths  $\lambda_{u1} + \Delta\lambda$  to  $\lambda_{un} + \Delta\lambda$  and are to be transmitted along said redundant optical fiber;

the W-MULDEM unit includes an array waveguide diffraction grating (AWG) having two ports, which are to be respectively connected to said current-use optical fiber and said redundant optical fiber, and  $n$  ports, which are to be connected to optical fibers corresponding to said ONUs;

the W-MULDEM unit demultiplexes to said ports corresponding to said ONUs said downstream optical signals that have wavelengths  $\lambda_{d1}$  to  $\lambda_{dn}$  and are received along said current-use optical fiber, or said downstream optical signals that have wavelengths  $\lambda_{d1}+\Delta\lambda$  to  $\lambda_{dn}+\Delta\lambda$  and are received along said redundant optical fiber, or multiplexes, to said port corresponding to said current-use optical fiber or said redundant optical fiber, said upstream optical signals that have wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$  or wavelengths  $\lambda_{u1}+\Delta\lambda$  to  $\lambda_{un}+\Delta\lambda$  and that are received along said optical fibers corresponding to said ONUs; and

a wavelength difference between said downstream optical signal and said upstream optical signal corresponding to each of said ONUs is integer times a free spectrum range (FSR) of said AWG.

2. An optical wavelength division multiplexing access system according to claim 1, characterized in that said transmission means includes:

switching means for changing from a current-use optical fiber to a redundant optical fiber;

a supervisory light source for outputting current-use fiber supervisory light and reserve fiber supervisory light having wavelengths  $\lambda_{s0}$  and  $\lambda_{s1}$  that differ from the wavelengths of said upstream optical signals and said downstream optical signals;

a supervisory control unit, for detecting said

supervisory light having wavelengths  $\lambda_{s0}$  and  $\lambda_{s1}$  that is received along said current-use optical fiber and said redundant optical fiber, and outputting a selection signal to said switching means to change from said current-use optical fiber to said redundant optical fiber;

a multiplexing unit, for multiplexing said current-use fiber supervisory light having wavelength  $\lambda_{s0}$  and an optical signal transmitted along said current-use optical fiber;

a demultiplexing unit, for demultiplexing said current-use fiber supervisory light having wavelength  $\lambda_{s0}$  from an optical signal transmitted along said current-use optical fiber;

a multiplexing unit, for multiplexing said reserve fiber supervisory light having wavelength  $\lambda_{s1}$  and an optical signal transmitted along said redundant optical fiber; and

a demultiplexing unit, for demultiplexing said reserve fiber supervisory light having wavelength  $\lambda_{s1}$  from an optical signal transmitted along said redundant optical fiber.

3. An optical wavelength division multiplexing access system according to claim 1, characterized by:

when  $\lambda_{d1}$ ,  $\lambda_{d2}$ , . . . and  $\lambda_{dn}$  are defined as wavelengths of downstream optical signals that are transferred along said current-optical fiber and correspond to said ONUs, and when a wavelength interval is a constant, defining

$\lambda_{d1+k}$ ,  $\lambda_{d2+k}$ , . . . and  $\lambda_{dn+k}$  ( $k$  is an integer of one or greater to smaller than  $n$ ) as wavelengths of downstream optical signals that are transferred along said redundant optical fiber to said ONUs, and

5        when  $\lambda_{u1}$ ,  $\lambda_{u2}$ , . . . and  $\lambda_{un}$  are defined as wavelengths of upstream optical signals that are transferred along said current-optical fiber and correspond to said ONUs, and when a wavelength interval is a constant, defining  $\lambda_{u1+k}$ ,  $\lambda_{u2+k}$ , . . . and  $\lambda_{un+k}$  ( $k$  is an integer of one or  
10       greater) as wavelengths of upstream optical signals that are transferred along said redundant optical fiber to said ONUs.

4. An optical wavelength division multiplexing  
15       access system according to claim 3, characterized by:  
         replacing  $\lambda_{dn} + i$  with  $\lambda_{di}$  when  $\lambda_{dn} + i = \lambda_{di} + \text{FSR}$  is established; and  
         replacing  $\lambda_{un} + i$  with  $\lambda_{ui}$  when  $\lambda_{un} + i = \lambda_{ui} + \text{FSR}$  is established ( $i$  is an integer of 1 to  $k$ ).

20       5. An optical wavelength division multiplexing access system according to claim 1, characterized in that said OSU includes:

         switching means for changing from said upstream (or  
25       downstream) current-use optical fiber to said upstream (or downstream) redundant optical fiber; and

         a supervisory control unit, for collectively detecting

a transmission cutoff of upstream signals from said ONUs,  
and for transmitting a selection signal to said switching  
means.

5           6. An optical wavelength division multiplexing  
access system according to claim 1, characterized in that  
said OSU includes:

switching means for changing from said upstream (or  
downstream) current-use optical fiber to said upstream  
10 (or downstream) redundant optical fiber; and

a supervisory control unit, for individually detecting  
a transmission cutoff of upstream signals from said ONUs,  
and for transmitting a selection signal to said switching  
means.

15           7. An optical wavelength division multiplexing  
access system according to claim 1, characterized in that  
said OSU includes:

means for individually detecting a transmission cutoff  
20 of downstream signals.

8. An optical wavelength division multiplexing  
access system according to claim 2, characterized in that,  
under a condition wherein current-use optical receivers  
25 and current-use optical receivers are in the normal state,  
when said current-use fiber supervisory light having  
wavelength  $\lambda_{s0}$  is not detected and said reserve fiber

supervisory light having wavelength  $\lambda_{s1}$  is detected, or when said current-use fiber supervisory light having wavelength  $\lambda_{s0}$  is not detected and said reserve fiber supervisory light having wavelength  $\lambda_{s1}$  is also not detected, and when said upstream optical receivers of said OSU do not receive upstream optical signals, said supervisory control unit transmits a selection signal to perform communication using said redundant optical fiber.

9. An optical wavelength division multiplexing access system according to claim 5, characterized in that, when a transmission cutoff of all upstream optical signals is detected by said means that collectively detects a transmission cutoff of upstream optical signals from said ONUs, said supervisory control unit performs a process for transmitting a selection signal to perform communication using said redundant optical fiber.

10. An optical wavelength division multiplexing access system according to claim 6, characterized in that, when a transmission cutoff of all upstream optical signals is detected by said means that individually detects a transmission cutoff of upstream optical signals from said ONUs, said supervisory control unit performs a process for transmitting a selection signal to perform communication using said redundant optical fiber.

11. An optical wavelength division multiplexing access system according to claim 1, characterized in that, when a transmission cutoff of a plurality of upstream optical signals is detected by said means that individually detects  
5 a transmission cutoff of upstream optical signals from said ONUs, said supervisory control unit performs a process for transmitting a selection signal to perform communication using said redundant optical fiber.

10 12. An optical wavelength division multiplexing access system, whereby a center node (OSU) and n optical network units (ONUs) are arranged through a W-MULDEM unit, whereby a multiplexing section between said OSU and said W-MULDEM unit is established by extending a current-use  
15 downstream optical fiber, a current-use upstream optical fiber, a reserve downstream optical fiber and a reserve upstream optical fiber and access sections between said W-MULDEM unit and said individual ONUs are established by the extension of downstream optical fibers and of upstream  
20 optical fibers, whereby downstream optical signals from said OSU to said ONUs and upstream optical signals from said ONUs to said OSU are multiplexed, using wavelengths that are allocated to said individual ONUs, and resultant optical signals are transmitted across said multiplexing  
25 section, and whereby said W-MULDEM unit performs either wavelength multiplexing or wavelength division for said upstream or downstream optical signals to provide



bidirectional transmission, characterized in that:

the OSU includes

transmission means for multiplexing downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dn}$  that  
5 correspond to said ONUs and that are to be transmitted to said ONUs along said current-use downstream optical fiber, for multiplexing downstream optical signals having wavelengths  $\lambda_{d1}+\Delta\lambda$  to  $\lambda_{dn}+\Delta\lambda$  that correspond to said ONUs and that are to be transmitted to said ONUs along said  
10 reserve downstream optical fiber, and for selecting either said current-use downstream optical fiber or said reserve downstream optical fiber used for transmission, and

reception means for receiving upstream optical signals having wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$  transmitted along  
15 said current-use upstream optical fiber, or for receiving upstream optical signals having wavelengths  $\lambda_{u1}+\Delta\lambda$  to  $\lambda_{un}+\Delta\lambda$  transmitted along said reserve upstream optical fiber;

the ONUs receive, along said optical fibers extended  
20 across said access sections, corresponding downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dn}$  or corresponding downstream optical signals having wavelengths  $\lambda_{d1}+\Delta\lambda$  to  $\lambda_{dn}+\Delta\lambda$ , the ONUs transmit, to said optical fibers extended across said access sections,  
25 corresponding upstream optical signals that have wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$  and that are to be transmitted along said current-use optical fiber extended across said

multiplexing section, or corresponding upstream optical signals that have wavelengths  $\lambda_{u1}+\Delta\lambda$  to  $\lambda_{un}+\Delta\lambda$  and are to be transmitted along said redundant optical fiber;

the W-MULDEM unit includes

5 a downstream array waveguide diffraction grating (AWG) having two ports, which are to be respectively connected to said current-use downstream optical fiber and said reserve downstream optical fiber, and n ports, which are to be connected to optical fibers corresponding  
10 to said ONUs, and

an upstream array waveguide diffraction grating (upstream AWG) having two ports, which are to be respectively connected to said current-use upstream optical fiber and said reserve upstream optical fiber, and n ports, which  
15 are connected to said optical fibers corresponding to said ONUs; and

the W-MULDEM unit demultiplexes to said ports of said downstream AWG that correspond to said ONUs said downstream optical signals that have wavelengths  $\lambda_{d1}$  to  $\lambda_{dn}$  and are  
20 received along said current-use downstream optical fiber, or said downstream optical signals that have wavelengths  $\lambda_{d1}+\Delta\lambda$  to  $\lambda_{dn}+\Delta\lambda$  and are received along said reserve downstream optical fiber, or multiplexes, to said port corresponding to said current-use upstream optical fiber  
25 or said reserve upstream optical fiber, said upstream optical signals that have wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$  or wavelengths  $\lambda_{u1}+\Delta\lambda$  to  $\lambda_{un}+\Delta\lambda$  and that are transmitted to

said upstream AWG along said optical fibers corresponding to said ONUs.

13. An optical wavelength division multiplexing  
5 access system according to claim 12, characterized in that:  
said transmission means includes

switching means for changing from said upstream  
(or downstream) current-use optical fiber to said upstream  
(or downstream) redundant optical fiber,

10 a supervisory light source for outputting a  
current-use fiber supervisory light and a reserve fiber  
supervisory light having wavelengths  $\lambda_{s0}$  and  $\lambda_{s1}$  that differ  
from wavelengths of said upstream optical signals and said  
downstream optical signals,

15 a supervisory control unit, for detecting said  
supervisory lights having wavelengths  $\lambda_{s0}$  and  $\lambda_{s1}$  that  
are received along said upstream current-use fiber and  
said upstream reserve fiber, and for outputting a selection  
signal to said switching means to change from said upstream  
20 (or downstream) current-use fiber to said upstream (or  
downstream) reserve fiber,

a multiplexing unit, for multiplexing said  
current-use fiber supervisory light having wavelength  $\lambda_{s0}$   
and an optical signal transmitted along said downstream  
25 (or upstream) current-use optical fiber,

a demultiplexing unit, for demultiplexing said  
current-use fiber supervisory light having wavelength  $\lambda_{s0}$

from an optical signal transmitted along said upstream (or downstream) current-use optical fiber,

a multiplexing unit, for multiplexing said reserve fiber supervisory light having wavelength  $\lambda_{s1}$  and an optical signal transmitted along said downstream (or upstream) redundant optical fiber, and

a demultiplexing unit, for demultiplexing said reserve fiber supervisory light having wavelength  $\lambda_{s1}$  from an optical signal transmitted along said upstream (or downstream) redundant optical fiber; and

said W-MULDEM unit includes

a demultiplexing unit, for demultiplexing said current-use optical fiber supervisory light having wavelength  $\lambda_{s0}$ , which has been multiplexed with said optical signal and has been received along said downstream (or upstream) current-use optical fiber,

a multiplexing unit, for re-multiplexing said current-use optical fiber supervisory light having wavelength  $\lambda_{s0}$  and an optical signal transmitted along said upstream (or downstream) current-use optical fiber,

a demultiplexing unit, for demultiplexing said redundant optical fiber supervisory light having wavelength  $\lambda_{s1}$  that has been multiplexed with an optical signal and received along said downstream (or upstream) redundant optical fiber, and

a multiplexing unit, for re-multiplexing said redundant optical fiber supervisory light having wavelength

$\lambda_{s1}$  and an optical signal transmitted along said upstream (or downstream) optical fiber.

14. An optical wavelength division multiplexing access system according to claim 12, characterized by:

when  $\lambda_{d1}$ ,  $\lambda_{d2}$ , . . . and  $\lambda_{dn}$  are defined as wavelengths of downstream optical signals that are transferred along said current-optical fiber and correspond to said ONUs, and when a wavelength interval is a constant, defining  $\lambda_{d1+k}$ ,  $\lambda_{d2+k}$ , . . . and  $\lambda_{dn+k}$  ( $k$  is an integer of one or greater to smaller than  $n$ ) as wavelengths of downstream optical signals that are transferred along said redundant optical fiber to said ONUs, and

when  $\lambda_{u1}$ ,  $\lambda_{u2}$ , . . . and  $\lambda_{un}$  are defined as wavelengths of upstream optical signals that are transferred along said current-optical fiber and correspond to said ONUs, and when a wavelength interval is a constant, defining  $\lambda_{u1+k}$ ,  $\lambda_{u2+k}$ , . . . and  $\lambda_{un+k}$  ( $k$  is an integer of one or greater) as wavelengths of upstream optical signals that are transferred along said redundant optical fiber to said ONUs.

15. An optical wavelength division multiplexing access system according to claim 14, characterized by:

replacing  $\lambda_{dn} + i$  with  $\lambda_{di}$  when  $\lambda_{dn} + i = \lambda_{di} + \text{FSR}$  is established; and

replacing  $\lambda_{un} + i$  with  $\lambda_{ui}$  when  $\lambda_{un} + i = \lambda_{ui} + \text{FSR}$

is established (i is an integer of 1 to k).

16. An optical wavelength division multiplexing access system according to claim 12, characterized in that  
5 said OSU includes:

switching means for changing from said upstream (or downstream) current-use optical fiber to said upstream (or downstream) redundant optical fiber; and

10 a supervisory control unit, for collectively detecting a transmission cutoff of upstream signals from said ONUs, and for transmitting a selection signal to said switching means.

17. An optical wavelength division multiplexing  
15 access system according to claim 12, characterized in that said OSU includes:

switching means for changing from said upstream (or downstream) current-use optical fiber to said upstream (or downstream) redundant optical fiber; and

20 a supervisory control unit, for individually detecting a transmission cutoff of upstream signals from said ONUs, and for transmitting a selection signal to said switching means.

25 18. An optical wavelength division multiplexing access system according to claim 12, characterized in that said OSU includes:

means for individually detecting a transmission cutoff of downstream signals.

5        19. An optical wavelength division multiplexing access system according to claim 13, characterized in that, under a condition wherein current-use optical receivers and current-use optical receivers are in the normal state, when said current-use fiber supervisory light having wavelength  $\lambda_{s0}$  is not detected and said reserve fiber  
10        supervisory light having wavelength  $\lambda_{s1}$  is detected, or when said current-use fiber supervisory light having wavelength  $\lambda_{s0}$  is not detected and said reserve fiber supervisory light having wavelength  $\lambda_{s1}$  is also not detected, and when said upstream optical receivers of said OSC do  
15        not receive upstream optical signals, said supervisory control unit transmits a selection signal to perform communication using said redundant optical fiber.

20        20. An optical wavelength division multiplexing access system according to claim 16, characterized in that, when a transmission cutoff of all upstream optical signals is detected by said means that collectively detects a transmission cutoff of upstream optical signals from said  
25        ONUs, said supervisory control unit performs a process for transmitting a selection signal to perform communication using said redundant optical fiber.

21. An optical wavelength division multiplexing access system according to claim 17, characterized in that, when a transmission cutoff of all upstream optical signals is detected by said means that individually detects a transmission cutoff of upstream optical signals from said ONUs, said supervisory control unit performs a process for transmitting a selection signal to perform communication using said redundant optical fiber.

22. An optical wavelength division multiplexing access system according to claim 17, characterized in that, when a transmission cutoff of a plurality of upstream optical signals is detected by said means that individually detects a transmission cutoff of upstream optical signals from said ONUs, said supervisory control unit performs a process for transmitting a selection signal to perform communication using said redundant optical fiber.

23. An optical wavelength division multiplexing access system according to claim 12, characterized in that wavelengths of downstream current-use optical signals that correspond to said ONUs are equalized with wavelengths of upstream current-use optical signals, and wavelengths of downstream reserve optical signals are equalized with wavelengths of upstream reserve optical signals.

24. An optical wavelength division multiplexing



access system according to claim 12, characterized in that:  
said OSU includes

means for oscillating optical carriers having  
wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$ , which are used for upstream signals,  
5 so as to permit said ONUs to generate upstream optical  
signals, and for multiplexing said optical carriers and  
transmitting a resultant carrier to said downstream  
current-use optical fiber, and

means for oscillating optical carriers having  
10 wavelengths  $\lambda_{u1} + \Delta\lambda_u$  to  $\lambda_{un} + \Delta\lambda_u$ , which are used for upstream  
signals, so as to permit said ONUs to generate upstream  
optical signals, and for multiplexing said optical carriers  
and transmitting a resultant carrier to said downstream  
redundant optical fiber;

15 said ONUs include

means for modulating corresponding optical  
carriers, used for upstream signals, from among those that  
are received while multiplexed with downstream optical  
signals, and transmitting thereby obtained signals as  
20 upstream optical signals having wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$ ,  
or wavelengths  $\lambda_{u1} + \Delta\lambda_u$  to  $\lambda_{un} + \Delta\lambda_u$ ;

a wavelength difference between said downstream  
optical signals and said upstream optical signals  
corresponding to said ONUs is defined as integer times  
25 a free spectrum range (FRS) of said downstream AWG; and

said downstream AWG provided for said W-MULDEM unit  
is so constituted as to separate, at the same time, said

downstream optical signals and said optical carriers, used for upstream signals, which correspond to said ONUs.

25. An optical wavelength division multiplexing access system according to claim 12, characterized in that: said OSU includes

means for oscillating optical carriers having wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$ , which are used for upstream signals, so as to permit said ONUs to generate upstream optical signals, and for multiplexing said optical carriers and transmitting a resultant carrier to said downstream current-use optical fiber, and

means for oscillating optical carriers having wavelengths  $\lambda_{u1} + \Delta\lambda_u$  to  $\lambda_{un} + \Delta\lambda_u$ , which are used for upstream signals, so as to permit said ONUs to generate upstream optical signals, and for multiplexing said optical carriers and transmitting a resultant carrier to said downstream redundant optical fiber;

said W-MULDEM unit includes, in addition to said downstream AWG and said upstream AWG,

two wavelength group demultiplex filters, for demultiplexing downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dn}$ , which are received along said downstream current-use optical fiber from said optical carriers having wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$  that are used for upstream signals, and for demultiplexing said downstream optical signals having wavelengths  $\lambda_{d1} + \Delta\lambda_d$  to  $\lambda_{dn} + \Delta\lambda_d$ ,

which are received, along said downstream redundant optical fiber, from said optical carriers having wavelengths  $\lambda_{u1} + \Delta\lambda_u$  to  $\lambda_{un} + \Delta\lambda_u$  that are used for upstream signals,

an upstream signal optical carrier AWG, for  
5 routing said optical carriers having wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$ , used for upstream signals, to ports corresponding to said ONUs, and

n wavelength group coupling filters, for  
multiplexing said downstream optical signals that are  
10 sorted by said downstream AWG and said optical carriers, used for upstream signals, that are sorted by said upstream signal optical carrier AWG, and transmitting the resultant signals to said downstream optical fibers that correspond to said ONUs;

15 said ONUs are so constituted as to modulate corresponding optical carriers, used for upstream signals, from among those that are received while multiplexed with said downstream optical signals, and to transmit the obtained signals as upstream optical signals having  
20 wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$ , or wavelengths  $\lambda_{u1} + \Delta\lambda_u$  to  $\lambda_{un} + \Delta\lambda_u$ .

26. An optical wavelength division multiplexing access system according to claim 25, characterized by:

when  $\lambda_{d1}$ ,  $\lambda_{d2}$ , . . . and  $\lambda_{dn}$  are defined as wavelengths  
25 of downstream optical signals that are transferred along said current-optical fiber and correspond to said ONUs, and when a wavelength interval is a constant, defining

$\lambda_{d1+k}$ ,  $\lambda_{d2+k}$ , . . . and  $\lambda_{dn+k}$  ( $k$  is an integer of one or greater to smaller than  $n$ ) as wavelengths of downstream optical signals that are transferred along said redundant optical fiber to said ONUs, and

5        when  $\lambda_{u1}$ ,  $\lambda_{u2}$ , . . . and  $\lambda_{un}$  are defined as wavelengths of upstream optical signals that are transferred along said current-optical fiber and correspond to said ONUs, and when a wavelength interval is a constant, defining  $\lambda_{u1+k}$ ,  $\lambda_{u2+k}$ , . . . and  $\lambda_{un+k}$  ( $k$  is an integer of one or  
10       greater) as wavelengths of upstream optical signals that are transferred along said redundant optical fiber to said ONUs.

27. An optical wavelength division multiplexing  
15       access system according to claim 26, characterized by:  
      replacing  $\lambda_{dn} + i$  with  $\lambda_{di}$  when  $\lambda_{dn} + i = \lambda_{di} + \text{FSR}$  is established; and  
      replacing  $\lambda_{un} + i$  with  $\lambda_{ui}$  when  $\lambda_{un} + i = \lambda_{ui} + \text{FSR}$  is established ( $i$  is an integer of 1 to  $k$ ).

20       28. An optical wavelength division multiplexing access system according to claim 26, characterized in that said means for oscillating said optical carriers, having wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$ , that are used for upstream signals,  
25       and said means for oscillating said optical carriers, having wavelengths  $\lambda_{u1+k}$  to  $\lambda_{un+k}$ , that are used for upstream signals, are constituted by one means for oscillating

optical carriers having wavelengths  $\lambda_{u1}$  to  $\lambda_{un+k}$ ; and said optical carriers having wavelengths  $\lambda_{u1}$  to  $\lambda_{un+1}$ , used for upstream signals, are transmitted to said downstream current-use optical fiber and said downstream redundant optical fiber.

29. An optical wavelength division multiplexing access system according to claim 13, characterized in that: said transmission means includes

n current-use optical transmitters and n reserve optical transmitters, for transmitting downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$  and downstream optical signals having wavelengths  $\lambda_{dpl}$  to  $\lambda_{dpn}$ ,

a downstream current-use wavelength multiplexing unit, having n ports to be connected to said n current-use optical transmitters and one port to be connected to said downstream current-use optical fiber, and

a downstream reserve wavelength multiplexing unit, having n ports to be connected to said n reserve optical transmitters and one port to be connected to said downstream optical fiber;

said downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$ , which are received from said n current-use optical transmitters and are multiplexed by said downstream current-use wavelength multiplexing unit, and a resultant signal is output to said downstream current-use optical fiber;

said downstream optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ , which are received from said  $n$  reserve optical transmitters, are multiplexed by said downstream reserve wavelength multiplexing unit, and a resultant signal is  
5 output to said downstream redundant optical fiber; and

said current-use and reserve optical transmitters include means for selecting the presence/absence of an optical output in accordance with a selection signal received from said supervisory control unit.

10

30. An optical wavelength division multiplexing access system according to claim 13, characterized in that:  
said transmission means includes

$n$  current-use optical transmitters and  $n$  reserve  
15 optical transmitters, for transmitting downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$  and downstream optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ ,

$n$  downstream current-use optical switches, for setting ON or OFF for the output of received optical signals,

20 a downstream current-use multiplexing unit, having  $n$  ports to be connected to said  $n$  downstream current-use optical switches and one port to be connected to said downstream current-use optical fiber,

$n$  downstream reserve optical switches, for  
25 setting ON or OFF for the input of received optical switches, and

a downstream reserve multiplexing unit, having

n ports to be connected to said n downstream reserve optical switches and one port to be connected to said downstream redundant optical fiber;

said downstream optical signals transmitted by said current-use optical transmitters and said reserve optical transmitters are received by said optical switches, and outputs of said optical switches are selected in accordance with a selection signal transmitted by said supervisory control unit;

said downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$ , output by said n current-use optical switches, are multiplexed by said downstream current-use multiplexing unit and a resultant signal is output to said downstream current-use optical fiber;

said downstream optical signals having wavelengths  $\lambda_{dpl}$  to  $\lambda_{dpn}$ , output by said n reserve optical switches, are multiplexed by said downstream reserve multiplexing unit and a resultant signal is output to said downstream current-use optical fiber; and

when said downstream current-use optical fiber is employed for transmission of downstream optical signals to said ONUs, said downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$ , corresponding to said ONUs, are multiplexed, and when said downstream redundant optical fiber is employed for transmission, said downstream optical signals having wavelengths  $\lambda_{dpl}$  to  $\lambda_{dpn}$ , corresponding to said ONUs, are multiplexed, so that the transmission

is performed by selecting either said downstream current-use optical fiber, or said downstream redundant optical fiber.

5           31. An optical wavelength division multiplexing access system according to claim 13, characterized in that: said transmission means includes

          n current-use optical transmitters for, upon receiving downstream electric signals, transmitting  
10 downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$ , and n reserve optical transmitters, for, upon receiving downstream electric signals, transmitting downstream optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ ,

          a downstream current-use multiplexing unit,  
15 having n ports to be connected to said n current-use optical transmitters and one port to be connected to a downstream current-use optical switch,

          a downstream reserve multiplexing unit, having n ports to be connected to said n reserve optical transmitters  
20 and one port to be connected to a downstream reserve optical switch,

          one downstream current-use optical switch, for setting ON/OFF for the output of a multiplexed downstream optical signal received from said downstream current-use  
25 multiplexing unit, and

          one downstream current-use optical switch, for setting ON/OFF for the output of a multiplexed downstream



optical signal received from said downstream reserve multiplexing unit;

said downstream current-use optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dwn}$ , output by said n current-use optical transmitters, are multiplexed by said downstream current-use multiplexing unit and a resultant signal is output to said downstream current-use optical switch;

said downstream reserve optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ , output by said n reserve optical transmitters, are multiplexed by said downstream reserve multiplexing unit and a resultant signal is output to said downstream reserve optical switch; and

either a current-use optical fiber or a redundant optical fiber to be used for output is selected in accordance with a selection signal transmitted by said supervisory control unit.

32. An optical wavelength division multiplexing access system according to claim 13, characterized in that:

a wavelength  $\lambda_{dpk}$  ( $k = 1$  to  $n$ ) is set as  $\lambda_{dwk} + \Delta\lambda_d$  ( $k = 1$  to  $n$ ;  $\Delta\lambda_d$  is a constant value);

said transmission means includes

n current-use optical transmitters and n reserve optical transmitters for, upon receiving downstream electric signals, outputting downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$  and downstream optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ ,

n optical switches, used to select said current-use optical transmitters that transmit a downstream optical signal having wavelength  $\lambda_{dwk}$  (k is an integer of one or greater to n or smaller), or said reserve optical transmitters that transmit a downstream optical signal having wavelength  $\lambda_{dpk}$  (k is an integer of one or greater to n or smaller), and

a downstream array waveguide diffraction grating (downstream AWG), having n ports to be connected to said n optical switches and two ports to be connected to said downstream current-use optical fiber and said redundant optical fiber; and

said downstream optical signals having wavelength  $\lambda_{dwk}$  and wavelength  $\lambda_{dpk}$  are transmitted from said current-use optical transmitters to said optical switches, either said downstream optical signal having wavelength  $\lambda_{dwk}$  or wavelength  $\lambda_{dpk}$  is selected and output by said n optical switches to said downstream AWG, and in accordance with said downstream optical signal having said selected wavelength, said downstream current-use optical fiber or said downstream redundant optical fiber is employed to multiplex and output the resultant signal.

33. An optical wavelength division multiplexing access system according to claim 13, characterized in that:  
a wavelength  $\lambda_{dpk}$  (k = 1 to n) is set as  $\lambda_{dwk} + \Delta\lambda_d$  (k = 1 to n;  $\Delta\lambda_d$  is a constant value);

said transmission means includes

n current-use optical transmitters for selecting and transmitting downstream signals having either wavelength  $\lambda_{dwk}$  (k is an integer of one or greater to n or smaller) or wavelength  $\lambda_{dpk}$  (k is an integer of one or greater or n or smaller), and

a downstream array waveguide diffraction grating (downstream AWG), having n ports to be connected to said n optical transmitters and two ports to be connected to said downstream current-use optical fiber and said redundant optical fiber;

said downstream optical signals having wavelength  $\lambda_{dwk}$  (k is an integer of one or greater to n or smaller) or wavelength  $\lambda_{dpk}$  (k is an integer of one or greater to n or smaller) are selected in accordance with a selection signal received from said supervisory control unit and are output by said optical transmitters; and

said downstream AWG multiplexes and outputs an obtained signal along said downstream optical fiber or said downstream redundant optical fiber that is consonant with said downstream optical signals having said selected wavelength.

34. An optical wavelength division multiplexing access system according to claim 13, characterized in that: said transmission means includes

n current-use optical receivers, for converting

received upstream optical signals having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  into upstream electric signals and outputting said upstream electric signals, and  $n$  reserve optical receivers, for converting received upstream optical signals having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$  into upstream electric signals and for outputting said upstream electric signals,

an upstream current-use demultiplexing unit, having  $n$  ports to be connected to said  $n$  current-use optical receivers and one port to be connected to said upstream current-use optical fiber, and

an upstream reserve demultiplexing unit, having  $n$  ports to be connected to said  $n$  reserve optical receivers and one port to be connected to said upstream reserve fiber;

said upstream optical signals received along said upstream current-use optical fiber are divided by said upstream current-use demultiplexing unit and transmitted to said current-use optical receivers;

said upstream optical signals received along said upstream redundant optical fiber are divided by said upstream demultiplexing unit and transmitted to said reserve optical receivers; and

upstream electric signals to be output are selected in accordance with a selection signal transmitted by said supervisory control unit.

35. An optical wavelength division multiplexing access system according to claim 13, characterized in that:

said transmission means includes

n current-use optical receivers, for converting received upstream optical signals having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  into upstream electric signals and outputting said upstream electric signals, and n reserve optical receivers, for converting received upstream optical signals having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$  into upstream electric signals and for outputting said upstream electric signals,

an upstream current-use demultiplexing unit, having n ports to be connected to said n current-use optical receivers and one port to be connected to said upstream current-use optical fiber,

an upstream reserve demultiplexing unit, having n ports to be connected to said n reserve optical receivers and one port to be connected to said upstream reserve fiber,

one upstream current-use optical switch, used to set ON/OFF for the output, to said upstream current-use demultiplexing unit, of upstream optical signals received from said upstream current-use demultiplexing unit, and

one upstream reserve optical switch, used to set ON/OFF for the output, to said upstream reserve demultiplexing unit, of upstream optical signals received from said upstream reserve demultiplexing unit;

when said upstream current-use optical switch and said upstream reserve optical switch are set to ON or OFF in accordance with a selection signal received from said supervisory control unit, either a multiplexed upstream

optical signal, transmitted along said upstream current-use optical fiber, or a multiplexed upstream signal, transmitted along said upstream redundant optical fiber, is selected and is output to said upstream current-use demultiplexing unit or said upstream reserve demultiplexing unit, and signals obtained by said demultiplexing unit are transmitted to said current-use optical receivers or said reserve optical receivers.

36. An optical wavelength division multiplexing access system according to claim 13, characterized in that: said transmission means includes

n current-use optical receivers, for converting received upstream optical signals having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  into upstream electric signals and outputting said upstream electric signals, and n reserve optical receivers, for converting received upstream optical signals having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$  into upstream electric signals and for outputting said upstream electric signals,

an upstream current-use demultiplexing unit, having n ports to be connected to said n current-use optical receivers and one port to be connected to said upstream current-use optical fiber,

an upstream reserve demultiplexing unit, having n ports to be connected to said n reserve optical receivers and one port to be connected to said upstream reserve fiber,

n upstream current-use optical switches, used

to set ON/OFF for the output, to said upstream current-use demultiplexing unit, of upstream optical signals received from said upstream current-use demultiplexing unit, and

n upstream current-use optical switches, used  
5 to set ON/OFF for the output, to said upstream current-use demultiplexing unit, of upstream optical signals received from said upstream current-use demultiplexing unit;

a multiplexed upstream optical signal transmitted to said upstream current-use demultiplexing unit along  
10 said upstream current-use fiber is demultiplexed and obtained signals are output to said upstream current-use optical switches;

a multiplexed upstream optical signal transmitted to said upstream reserve demultiplexing unit along said  
15 upstream reserve fiber is demultiplexed and obtained signals are output to said upstream reserve optical switches; and

when said upstream current-use optical switches or said upstream reserve optical switches are set to ON/OFF  
20 in accordance with a selection signal received from said supervisory control unit, said upstream current-use demultiplexing unit or said upstream reserve demultiplexing unit is selected and signals are transmitted to said current-use optical receivers or said reserve optical  
25 receivers.

37. An optical wavelength division multiplexing

access system according to claim 13, characterized in that:  
a wavelength  $\lambda_{upk}$  ( $k = 1$  to  $n$ ) is set as  $\lambda_{uwk} + \Delta\lambda_u$  ( $k = 1$  to  $n$ ;  $\Delta\lambda_u$  is a constant value);

said transmission means includes

5           optical transmitters for selecting and outputting  
upstream optical signals having either wavelength  $\lambda_{uwk}$   
( $k$  is an integer of one or greater to  $n$  or smaller) or  
wavelength  $\lambda_{upk}$  ( $k$  is an integer of one or greater or  $n$   
or smaller),

10            $n$  optical receivers, for converting, into  
electric signals, received upstream optical signals having  
either wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$ , or wavelengths  $\lambda_{up1}$  to  
 $\lambda_{upn}$ , and outputting said electric signals, and

          an upstream array waveguide diffraction grating  
15 (upstream AWG), having two ports to be connected to said  
upstream current-use optical fiber and said redundant  
optical fiber and  $n$  ports to be connected to said  $n$  optical  
receivers;

          said upstream optical signal having wavelength  $\lambda_{uwk}$   
20 ( $k$  is an integer of one or greater to  $n$  or smaller) or  
wavelength  $\lambda_{upk}$  ( $k$  is an integer of one or greater to  $n$   
or smaller), which has been selected in accordance with  
a selection signal received from said supervisory control  
unit, is transmitted to said W-MULDEM unit; and

25           said W-MULDEM unit outputs said upstream optical signal  
to said current-use optical fiber or said redundant optical  
fiber that is consonant with said wavelength, and said



upstream AWG demultiplexes said upstream optical signal and transmits the obtained signals to said optical receivers.

5           38. An optical wavelength division multiplexing access system according to claim 37, characterized in that: said OSU includes

              means for oscillating optical carriers having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$ , which are used for upstream signals, 10 so as to permit said ONUs to generate upstream optical signals, and for multiplexing said optical carriers and transmitting a resultant carrier to said downstream current-use optical fiber, and

              n optical transmitters, for selecting and 15 outputting an upstream optical signal having wavelength  $\lambda_{uwk}$  (k is an integer of one or greater to n or smaller) or wavelength  $\lambda_{upk}$  (k is an integer of one or greater to n or smaller), and an upstream signal AWG, having two ports to be connected to said current-use optical fiber and said 20 redundant optical fiber and n ports to be connected to said optical transmitters, both of said optical transmitters and said upstream signal AWG being provided as means, for oscillating optical carriers having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$ , that are used for upstream signals, 25 so as to permit said ONUs to generate upstream optical signals, and for multiplexing said optical carriers and transmitting a resultant carrier to said downstream

redundant optical fiber;

said upstream optical signal, which has wavelength  $\lambda_{uwk}$  (k is an integer of one or greater to n or smaller) or wavelength  $\lambda_{upk}$  (k is an integer of one or greater to n or smaller), is output by said upstream signal AWG to either said current-use optical fiber or said redundant optical fiber, which is consonant with a selection signal transmitted by said supervisory control unit, and is multiplexed with a downstream optical signal and the resultant signal is transmitted to said wavelength multiplexer.

39. An optical wavelength division multiplexing access system according to claim 38, characterized in that said optical transmitters add, to downstream signals, a selection signal transmitted by said supervisory control unit and transmit the obtained signals to said ONUs.

40. An optical wavelength division multiplexing access system, whereby a center node (OSU) and n optical network units (ONUs) are arranged by using a W-MULDEM unit, whereby a multiplexing section between said OSU and said W-MULDEM unit is established by extending a downstream current-use optical fiber, an upstream current-use optical fiber, a downstream redundant optical fiber and an upstream redundant optical fiber, and access sections between said W-MULDEM unit and said individual ONUs are established

by the extension of downstream optical fibers and upstream optical fibers, whereby downstream optical signals from said OSU to said ONUs and upstream optical signals from said ONUs to said OSU are multiplexed using wavelengths that are allocated to individual ONUs and the resultant signals are transmitted across said multiplexing section, and whereby said W-MULDEM unit performs wavelength multiplexing or wavelength division for said upstream or downstream optical signals to provide bidirectional transmission, characterized in that:

the OSU includes

transmission means for multiplexing downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$  that correspond to said ONUs and that are to be transmitted to said ONUs along said downstream current-use optical fiber, for multiplexing downstream optical signals having wavelengths  $\lambda_{dpl}$  to  $\lambda_{dpn}$  that correspond to said ONUs and that are to be transmitted to said ONUs along said downstream redundant optical fiber, and for selecting either said downstream current-use optical fiber or said downstream redundant optical fiber for use for transmission, and

reception means for receiving upstream optical signals having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  along said upstream current-use optical fiber or for receiving upstream optical signals having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$  along said upstream redundant optical fiber;

the individual ONUs receive corresponding downstream

optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$  or  
corresponding downstream optical signals having  
wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ , which are received along said  
optical fibers extended across said access sections, and  
5 transmit, to said optical fibers extended across said access  
sections, corresponding upstream optical signals that have  
wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  and are to be transmitted along  
said upstream current-use optical fiber extended across  
said multiplexing section, or corresponding upstream  
10 optical signals that have wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$  and  
are to be transmitted along said upstream redundant optical  
fiber;

said W-MULDEM unit includes

a downstream current-use demultiplexing unit  
15 corresponding to said downstream current-use optical fiber,  
and a downstream reserve demultiplexing unit corresponding  
to said downstream redundant optical fiber,

n wavelength group coupling filters for  
multiplexing, for corresponding ports, downstream optical  
20 signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$ , which have been  
demultiplexed by said current-use demultiplexing unit,  
and downstream optical signals having wavelengths  $\lambda_{dp1}$   
to  $\lambda_{dpn}$ , which have been demultiplexed by said downstream  
reserve demultiplexing unit, and for outputting obtained  
25 signals to said downstream optical fibers that correspond  
to said ONUs,

an upstream current-use multiplexing unit

corresponding to said upstream current-use optical fiber and an upstream reserve multiplexing unit corresponding to said upstream redundant optical fiber, and

5           n wavelength group demultiplex filters, for dividing and transmitting, to corresponding ports of said upstream current-use multiplexing unit or said upstream reserve multiplexing unit, said upstream optical signals having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  and having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$ , all of which are received from said upstream  
10 optical fibers corresponding to said ONUs;

          said downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$ , which are received along said downstream current-use optical fiber, or said downstream optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ , which are received  
15 along said downstream redundant optical fiber, are divided into ports corresponding to said ONUs;

          said upstream optical signals having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$ , or said upstream optical signals having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$ , which are received from said upstream optical  
20 fibers corresponding to said ONUs, are merged at said port that corresponds to said upstream current-use optical fiber or said upstream redundant optical fiber; and

          different bands are provided for said wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$  of said downstream current-use optical signals and said wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  of said downstream reserve  
25 optical signals, and different bands are provided for said wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  of said upstream current-use

optical signals and said wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$  of said upstream reserve optical signals.

41. An optical wavelength division multiplexing  
5 access system according to claim 40, characterized in that wavelengths of downstream current-use optical signals that correspond to said ONUs are equalized with wavelengths of upstream reserve optical signals, and wavelengths of upstream current-use optical signals are equalized with  
10 wavelengths of downstream reserve optical signals.

42. An optical wavelength division multiplexing access system, whereby a center node (OSU) and n optical network units (ONUs) are arranged by using a W-MULDEM unit,  
15 whereby a multiplexing section between said OSU and said W-MULDEM unit is established by extending a downstream current-use optical fiber, an upstream current-use optical fiber, a downstream redundant optical fiber and an upstream redundant optical fiber, and access sections between said  
20 W-MULDEM unit and said individual ONUs are established by the extension of downstream optical fibers and upstream optical fibers, whereby downstream optical signals from said OSU to said ONUs and upstream optical signals from said ONUs to said OSU are multiplexed using wavelengths  
25 that are allocated to individual ONUs and the resultant signals are transmitted across said multiplexing section, and whereby said W-MULDEM unit performs wavelength

multiplexing or wavelength division for said upstream or downstream optical signals to provide bidirectional transmission, characterized in that:

the OSU includes

5                    transmission means for, when said ONUs are divided into two groups, #1 to #k and #k+1 to #n, and downstream optical signals are divided into two wavelength groups,  $\lambda_{d1}$  to  $\lambda_{dk}$  and  $\lambda_{dk+1}$  to  $\lambda_{dn}$ , multiplexing downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dk}$  so as to transmit  
10 downstream optical signals to said ONUs #1 to #k along said downstream current-use optical fiber, for multiplexing downstream optical signals having wavelengths  $\lambda_{dk+1}$  to  $\lambda_{dn}$  for transmission along said downstream redundant optical fiber, for multiplexing downstream  
15 optical signals having wavelengths  $\lambda_{dk+1}$  to  $\lambda_{dn}$  so as to transmit downstream optical signals to said ONUs #k+1 to #n along said downstream current-use optical fiber, and for multiplexing downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dk}$  for transmission along said  
20 downstream redundant optical fiber, so that either said downstream current-use optical fiber or said downstream redundant optical fiber is selected for transmission, and  
                  reception means for, when upstream optical signals are divided into two wavelength groups,  $\lambda_{u1}$  to  $\lambda_{uk}$  and  $\lambda_{uk+1}$  to  $\lambda_{un}$ , receiving upstream optical signals,  
25 for which wavelengths  $\lambda_{u1}$  to  $\lambda_{uk}$  for current use and wavelengths  $\lambda_{uk+1}$  to  $\lambda_{un}$  for reserve use are allocated

for said ONUs #1 to #k, and for which wavelengths  $\lambda_{k+1}$  to  $\lambda_n$  for current use and wavelengths  $\lambda_1$  to  $\lambda_k$  for reserve use are allocated for said ONUs #k+1 to #n;

said ONUs receive, along said downstream optical fibers  
5 at said access sections, downstream optical signals having corresponding wavelengths  $\lambda_{d1}$  to  $\lambda_{dk}$ , or wavelengths  $\lambda_{dk+1}$  to  $\lambda_{dn}$ , and transmit, to said upstream optical fibers, upstream optical signals having corresponding wavelengths  $\lambda_1$  to  $\lambda_k$  when said upstream current-use optical fiber  
10 at said multiplexing section is employed for transmission, or transmit upstream optical signals having corresponding wavelengths  $\lambda_{k+1}$  to  $\lambda_n$  when said upstream redundant optical fiber is employed for transmission;

said W-MULDEM unit includes

15 two ports to be connected to said downstream current-use optical fiber and said downstream redundant optical fiber,

a downstream current-use demultiplexing unit corresponding to said downstream current-use optical fiber  
20 and a downstream reserve demultiplexing unit corresponding to said downstream redundant optical fiber,

n wavelength group coupling filters, for multiplexing, for said individual ports, said downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dk}$  and  $\lambda_{dk+1}$   
25 to  $\lambda_{dn}$ , which have been demultiplexed by said downstream current-use demultiplexing unit, and said downstream optical signals having wavelengths  $\lambda_{dk+1}$  to  $\lambda_{dn}$  and  $\lambda_{d1}$



to  $\lambda_{dk}$ , which have been demultiplexed by said downstream reserve demultiplexing unit, and for transmitting obtained signals to said upstream current-use optical fiber and said upstream redundant optical fiber,

5           two ports to be connected to said upstream current-use optical fiber and said upstream redundant optical fiber,

          an upstream current-use multiplexing unit corresponding to said upstream current-use optical fiber  
10       and an upstream reserve multiplexing unit corresponding to said upstream redundant optical fiber, and

          n wavelength group demultiplex filters, for dividing said upstream optical signals having wavelengths  $\lambda_{u1}$  to  $\lambda_{uk}$  and  $\lambda_{uk+1}$  to  $\lambda_{un}$  and wavelengths  $\lambda_{uk+1}$  to  $\lambda_{un}$   
15       and  $\lambda_{u1}$  to  $\lambda_{uk}$ , which are received along said upstream optical fiber corresponding to said ONUs, and outputting the signals to said corresponding ports of said upstream current-use multiplexing unit or said upstream reserve multiplexing unit; and

20       said downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dn}$ , which are received along said downstream current-use optical fiber or said downstream redundant optical fiber, are divided among said ports corresponding to said ONUs, and said upstream optical signals having  
25       wavelengths  $\lambda_{u1}$  to  $\lambda_{un}$ , which are received along said upstream optical fibers corresponding to said ONUs, are multiplexed at said port that corresponds to said upstream

current-use optical fiber or said redundant optical fiber.

43. An optical wavelength division multiplexing access system, whereby a center node (OSU) and n optical network units (ONUs) are arranged by using a W-MULDEM unit, whereby a multiplexing section between said OSU and said W-MULDEM unit is established by extending a downstream current-use optical fiber, an upstream current-use optical fiber, a downstream redundant optical fiber and an upstream redundant optical fiber, and access sections between said W-MULDEM unit and said individual ONUs are established by the extension of downstream optical fibers and upstream optical fibers, whereby downstream optical signals from said OSU to said ONUs and upstream optical signals from said ONUs to said OSU are multiplexed using wavelengths that are allocated to individual ONUs and the resultant signals are transmitted across said multiplexing section, and whereby said W-MULDEM unit performs wavelength multiplexing or wavelength division for said upstream or downstream optical signals to provide bidirectional transmission, characterized in that:

the OSU includes

transmission means for multiplexing downstream optical signals having wavelengths  $\lambda_{dwl}$  to  $\lambda_{dwn}$  that correspond to said ONUs and that are to be transmitted to said ONUs along said downstream current-use optical fiber, for multiplexing downstream optical signals having

wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$  that correspond to said ONUs and that are to be transmitted to said ONUs along said downstream redundant optical fiber, and for selecting either said downstream current-use optical fiber or said downstream  
5 redundant optical fiber for use for transmission,

reception means for receiving upstream optical signals having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  along said upstream current-use optical fiber or for receiving upstream optical signals having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$  along said upstream  
10 redundant optical fiber,

means for oscillating optical carriers, having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$ , which are used by said ONUs for generation of upstream signals, and for multiplexing said optical carriers and transmitting a resultant carrier to  
15 said downstream current-use optical fiber, and

means for oscillating optical carriers, having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$ , which are used by said ONUs for generation of upstream signals, and for multiplexing said optical carriers and transmitting a resultant carrier to  
20 said downstream redundant optical fiber;

the individual ONUs receive corresponding downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$  or corresponding downstream optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ , which are received along said  
25 optical fibers extended across said access sections, and transmit, to said optical fibers extended across said access sections, corresponding upstream optical signals that have

wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  and are to be transmitted along said upstream current-use optical fiber extended across said multiplexing section, or corresponding upstream optical signals that have wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$  and are to be transmitted along said upstream redundant optical fiber;

said W-MULDEM unit includes

a downstream array waveguide diffraction grating (downstream AWG), having two ports to be connected to said downstream current-use optical fiber and said downstream redundant optical fiber and  $n$  ports to be connected to said downstream optical fibers corresponding to said ONUs,

an upstream array waveguide diffraction grating (upstream AWG), having two ports to be connected to said upstream current-use optical fiber and said upstream redundant optical fiber and  $n$  ports to be connected to said upstream optical fibers corresponding to said ONUs,

two wavelength group demultiplex filters, for demultiplexing optical carriers having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$ , which are used for upstream signals, from downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$ , which are received along said downstream current-use optical fiber, and for demultiplexing optical carriers having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$ , which are used for upstream signals, from downstream optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ , which are received along said downstream redundant optical fiber,

an upstream signal optical carrier AWG, for dividing said optical carriers, which have wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  and are used for upstream signals, among said ports corresponding to said ONUs, and

5           n wavelength group coupling filters, for multiplexing said downstream optical signals, which have been demultiplexed by said downstream AWG, and said optical carriers, used for upstream signals, which have been demultiplexed by said upstream signal optical carrier AWG,  
10       and for transmitting the resultant signals to said downstream optical fibers corresponding to said ONUs;

      said downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$ , which are transmitted along said downstream current-use optical fiber to said downstream AWG, or said  
15       downstream optical signals having wavelengths  $\lambda_{dpl}$  to  $\lambda_{dpn}$ , which are transmitted along said downstream redundant optical fiber, are divided among said ports corresponding to said ONUs; and

      said upstream optical signals having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  or wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$ , which are transmitted  
20       to said upstream AWG along said upstream current-use optical fibers corresponding to said ONUs, are merged at said port corresponding to said upstream current-use optical fiber or said upstream redundant optical fiber.

25  
44. An optical wavelength division multiplexing access system according to claim 43, characterized by:

providing, instead of said upstream signal optical carrier AWG, an upstream current-use signal optical carrier AWG corresponding to said downstream current-use optical fiber and an upstream reserve signal optical carrier AWG corresponding to said downstream redundant optical fiber, and n wavelength group coupling filters for multiplexing, for individual ports, said upstream signal optical carriers having wavelengths  $\lambda_{uw1}$  to  $\lambda_{dwu}$ , which have been demultiplexed by said upstream current-use signal optical carrier AWG, and said upstream signal optical carriers having wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$ , which have been demultiplexed by said upstream reserve signal optical carrier AWG;

providing, instead of said downstream AWG, a downstream current-use AWG corresponding to said downstream current-use optical fiber and a downstream reserve AWG corresponding to said downstream redundant optical fiber, and n wavelength group coupling filters, for multiplexing, for individual ports, said downstream optical signals having wavelengths  $\lambda_{dw1}$  to  $\lambda_{dwn}$ , which have been demultiplexed by said downstream current-use AWG, and said downstream optical signals having wavelengths  $\lambda_{dp1}$  to  $\lambda_{dpn}$ , which have been demultiplexed by said downstream reserve AWG; and

providing, instead of said upstream AWG, an upstream current-use AWG corresponding to said upstream current-use optical fiber and an upstream reserve AWG corresponding

to said upstream redundant optical fiber, and  $n$  wavelength group demultiplex filters, for dividing said upstream optical signals having wavelengths  $\lambda_{uw1}$  to  $\lambda_{uwn}$  and wavelengths  $\lambda_{up1}$  to  $\lambda_{upn}$ , which are received along said upstream optical fibers corresponding to said ONUs, and for transmitting resultant signals to corresponding ports of said upstream current-use AWG or said reserve AWG.

45. An optical wavelength division multiplexing access system according to claim 43, characterized by: dividing said ONUs into two groups, #1 to # $k$  and # $k+1$  to # $n$ ;

when dividing downstream optical signals into two wavelength groups,  $\lambda_{d1}$  to  $\lambda_{dk}$  and  $\lambda_{dk+1}$  to  $\lambda_{dn}$ , allocating current-use wavelengths  $\lambda_{d1}$  to  $\lambda_{dk}$  and reserve wavelengths  $\lambda_{dk+1}$  to  $\lambda_{dn}$  for said ONUs #1 to # $k$ , and allocating current-use wavelengths  $\lambda_{dk+1}$  to  $\lambda_{dn}$  and reserve wavelengths  $\lambda_{d1}$  to  $\lambda_{dk}$  for said ONUs # $k+1$  to # $n$ ;

when dividing upstream optical signals into two wavelength groups,  $\lambda_{u1}$  to  $\lambda_{uk}$  and  $\lambda_{uk+1}$  to  $\lambda_{un}$ , allocating current-use wavelengths  $\lambda_{u1}$  to  $\lambda_{uk}$  and reserve wavelengths  $\lambda_{uk+1}$  to  $\lambda_{un}$  for said ONUs #1 to # $k$ , and allocating current-use wavelengths  $\lambda_{uk+1}$  to  $\lambda_{un}$  and reserve wavelengths  $\lambda_{u1}$  to  $\lambda_{uk}$  for said ONUs # $k+1$  to # $n$ ;

providing, instead of said upstream signal optical carrier AWG, an upstream current-use signal optical carrier demultiplexing unit that corresponds to said downstream

current-use optical fiber and an upstream reserve signal optical carrier demultiplexing unit that corresponds to said downstream redundant optical fiber, and n wavelength group coupling filters, for multiplexing, for individual ports, upstream signal optical carriers having wavelengths  $\lambda_{u1}$  to  $\lambda_{uk}$  and  $\lambda_{uk+1}$  to  $\lambda_{un}$ , which have been demultiplexed by said upstream current-use signal optical carrier demultiplexing unit, and upstream signal optical carriers having wavelengths  $\lambda_{uk+1}$  to  $\lambda_{un}$  and  $\lambda_{u1}$  to  $\lambda_{uk}$ , which have been demultiplexed by said upstream reserve signal optical carrier demultiplexing unit;

providing, instead of said downstream AWG, a downstream current-use demultiplexing unit that corresponds to said downstream current-use optical fiber and a downstream reserve demultiplexing unit that corresponds to said downstream redundant optical fiber, and n wavelength group coupling filters for multiplexing, for individual ports, downstream optical signals having wavelengths  $\lambda_{d1}$  to  $\lambda_{dk}$  and  $\lambda_{dk+1}$  to  $\lambda_{dn}$ , which have been demultiplexed by said downstream current-use demultiplexing unit, and downstream optical signals having wavelengths  $\lambda_{dk+1}$  to  $\lambda_{dn}$  and  $\lambda_{d1}$  to  $\lambda_{dk}$ , which have been demultiplexed by said downstream reserve demultiplexing unit; and

providing, instead of said upstream AWG, an upstream current-use multiplexing unit that corresponds to said upstream current-use optical fiber and an upstream reserve multiplexing unit that corresponds to said upstream



redundant optical fiber, and  $n$  wavelength group demultiplex filters, for demultiplexing upstream optical signals having wavelengths  $\lambda_{u1}$  to  $\lambda_{uk}$  and  $\lambda_{uk+1}$  to  $\lambda_{un}$  and wavelengths  $\lambda_{uk+1}$  to  $\lambda_{un}$  and  $\lambda_{u1}$  to  $\lambda_{uk}$ , which are received along said upstream optical fibers corresponding to said ONUs, and for transmitting resultant signals to corresponding ports of said upstream current-use multiplexing unit or said upstream reserve multiplexing unit.

46. An optical wavelength division multiplexing access system according to one of claims 1 to 45, characterized by:

allocating, for an arbitrary ONU, two wavelengths or more for a downstream current-use optical signal, a downstream reserve optical signal, an upstream current-use optical signal and an upstream reserve optical signal, so as to obtain a dual structure for optical fibers at said access sections.